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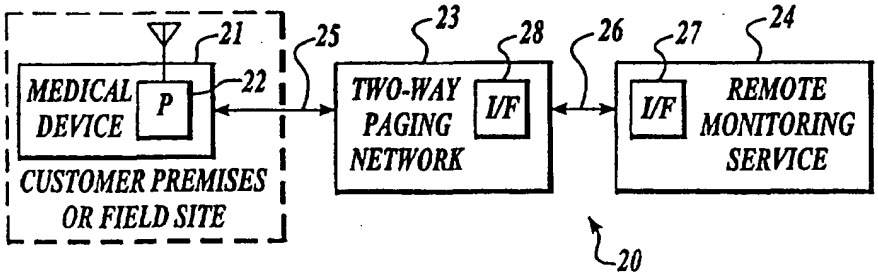

(57) Abstract

A medical device is configured to support two–way pager communication to remotely monitor the status and configuration of the medical device. A two–way pager module is incorporated into the medical device. A remote monitoring service is configured to regularly communicate with the medical device to initiate self–tests, obtain status information or provide reconfiguration information and software updates. The medical device then sends a return message to the remote monitoring service using the two–way paging network. The return message would include the requested information, self–test results, or acknowledgement that the reconfiguration or software update was performed. The system can be expanded so that the remote monitoring service can monitor a large number of medical devices. This system can be advantageously used to efficiently monitor a large number of portable or mobile medical devices at a low cost and in a manner that is transparent to the users of the medical devices. In addition, no extra infrastructure needs to be added to implement the system. In a further refinement, the medical devices may include a GPS module so that the location of the medical devices may be monitored.

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METHOD AND APPARATUS FOR REMOTE WIRELESS COMMUNICATION WITH A MEDICAL DEVICE

Field of the Invention

The present invention is related to communication systems for use with a medical device and, more particularly, to remote wireless communication systems for medical devices using a two-way paging system.

Background Information

Many medical devices such as, for example, defibrillators are monitored for status and condition. One conventional method to monitor the medical devices includes having a technician manually check and test the medical devices on a regular basis. These devices generally are kept at the customer's site and, because these devices tend to be complex, the customers or users are generally not trained to perform this monitoring process. Consequently, some of these devices are configured to communicate with an off-site monitoring service, which can remotely obtain the status and condition information. In addition, the monitoring service can remotely initiate self-tests and reconfiguration. These conventional systems tend to use either wired connections (e.g., LAN or telephone service) or wireless systems such as cellular telephone or specialized proprietary RF systems.

FIGURE 1 is a block diagram illustrative of a conventional medical device communication system 10 having a medical device 11, a communication network 12, and a remote monitoring service 13. As indicated by the dashed lines in FIGURE 1, the medical device 11 can be located at the user's premises or at a field site (e.g.,

when paramedics in responding to an emergency use a portable external defibrillator). The communication network 12 may be a wired system such as, for example, a normal telephone system 15 or a local area network (LAN) 16. Alternatively, the communication network 12 may be a wireless system such as, for example, a cellular telephone system 17 or a private wireless communication system 18 dedicated to monitoring medical devices. Some of these conventional wireless systems require that a vehicle with receiving equipment drive by the customer's premises in order to communicate with the medical device 11. The medical device 11 includes an interface 19 for communicating with the remote monitoring service 13 through the communication system 12.

The remote monitoring service 13 is configured to obtain status information from the medical device 11. For example, in a system adapted for monitoring a portable external defibrillator, the remote monitoring service 13 may be configured to obtain information such as battery charge, battery age, self-test results, configuration parameters, internal state (e.g., off, on, or charging), or even physiological data measured from a patient during treatment. The remote monitoring service 13 may also initiate self-tests or reconfigure the medical device 11.

These conventional systems have drawbacks such as having to be physically connected to a telephone line in the case of wired systems or having added special infrastructure that is relatively expensive to obtain and operate in the case of wireless systems. With the market for some medical devices expanding into households, there is a need for low cost, wireless remote communication system for medical devices.

Summary

In accordance with the present invention, a medical device is configured to support two-way pager communication is provided. In one aspect of the invention, a two-way pager module supporting digital communication is incorporated into the medical device. The two-way pager module allows a remote monitoring service to regularly communicate with the medical device to initiate self-tests, obtain status information and provide reconfiguration information. The two-way pager modules are commercially available and relatively inexpensive to purchase and operate. No additional infrastructure is needed (i.e., the paging service provider has the infrastructure). Also, the system is self-contained in the medical device and the operation is transparent to the user. The system can also be used with portable medical devices without connecting and reconnecting the portable medical device to

the communication network (i.e., as long as the medical device is within the service area of the paging service). Accordingly, using a two-way paging communication system advantageously avoids the physical constraints of wired systems at a lower cost than relatively expensive cellular and private wireless system. Further, using a two-way paging system avoids the need to provide a communication infrastructure or to use "drive-by" techniques as is required in some conventional private wireless systems.

In a further aspect of the present invention, the remote monitoring service is configured to initiate pages addressed to the desired medical device that include, for example, instructions (or codes representing instructions) for the medical device to provide status, perform self-tests or change the medical device's configuration. In one embodiment, the monitoring service initiates such pages by calling the "pager" number previously assigned to the desired medical device, using a telephone/modem connection. In one embodiment, the instructions are added to the page by providing a number or code representing the desired instruction. The paging service then generates a page with the desired instruction, addressed to the desired medical device. The medical device receives the page and then extracts and performs the instructions. The medical device may be instructed to transmit a message back to the paging service containing self-test results, status data or condition data using the two-way pager module.

In a preferred portable AED (automatic external defibrillator) embodiment, the two-way pager module includes a transmitter, receiver, antenna and signal processing circuitry. The medical device has a control unit with a processor that is programmed to operate the two-way pager module to receive pages containing digital data and to transmit return messages to the paging service (i.e., the paging switch). Because an AED typically includes a processor, in a further aspect of the present invention, the control task for the two-way pager module is simply added to AED's existing software.

In a further refinement of the present invention, the medical device may include a GPS module so that the location of the medical device may be monitored.

Brief Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated by reference to the following detailed description, when taken in conjunction with the accompanying drawings listed below.

FIGURE 1 is a block diagram illustrative of some conventional communication systems for medical devices.

FIGURE 2 is a block diagram illustrative of a remote wireless communication system for use with medical devices, according to one embodiment of the present invention.

FIGURE 3 is a flow diagram illustrative of the operation of the remote wireless communication system of FIGURE 2, according to one embodiment of the present invention.

FIGURE 4 is a block diagram illustrative of a defibrillator implementing the medical device in FIGURE 2, according to one embodiment of the present invention.

FIGURE 5 is a block diagram illustrative of the remote monitoring unit in FIGURE 2, according to one embodiment of the present invention.

FIGURE 6 is a flow diagram illustrative of the operation of the remote wireless communication system of FIGURE 2, according to another embodiment of the present invention.

FIGURE 7 is a block diagram illustrative of a medical device configured to provide information regarding the location of the medical device to a remote monitoring service, according to one embodiment of the present invention.

FIGURE 8 is a block diagram illustrative of a remote wireless and data network communication system for use with medical devices, according to one embodiment of the present invention.

FIGURES 9A and 9B are block diagrams illustrative of two embodiments of data network communication links between the remote monitoring service and the two-way paging network depicted in FIGURE 8, according to the present invention.

FIGURE 10 is a block diagram illustrative of a remote wireless communication system for use with medical devices, according to another embodiment of the present invention.

FIGURE 11 is a block diagram illustrative of a remote wireless communication system for use with smart subsystems of medical devices, according to one embodiment of the present invention.

Detailed Description

FIGURE 2 is a simplified diagram illustrative of a remote wireless communication system 20 for use with medical devices, according to one embodiment of the present invention. Communication system 20 includes a medical device 21 with a two-way pager module 22, a two-way paging network 23 and a

remote monitoring service 24. Although only one medical device is shown in FIGURE 2, it will be appreciated that the remote monitoring service 24 can monitor a relatively large number of medical devices (not shown) using the two-way paging network 23 of the communication system 20. The medical device 22 communicates with the remote monitoring service 24 through the two-way paging system 23. The two-way paging module 23 is a standard commercially available two-way paging module. In particular, the medical device 21 uses the two-way paging module 22 to interface with the paging system 23 through a wireless channel, indicated by an arrow 25. In addition, the two-way paging network 23 communicates with the remote monitoring service 24 through a channel (wired or wireless), indicated by an arrow 26. In one embodiment, the channel 26 is a standard telephone connection with standard modem interfaces 27 and 28 in remote monitoring service 24 and two-way paging network 23, respectively. As will be appreciated by those skilled in the art in light of this disclosure, the channel 26 need not be a standard telephone connection in other embodiments.

FIGURE 3 is a flow diagram illustrative of the operation of the remote wireless communication system 20 (FIGURE 2), according to one embodiment of the present invention. Referring to FIGS. 2 and 3, remote wireless communication system 20 operates as follows. In a block 31, the remote monitoring service 24 initiates a page addressed to the desired medical device (i.e., the medical device 12 in this example). The page includes, for example, instructions (or codes representing instructions) for the medical device 21 to provide status, perform self-tests or change the configuration (e.g., update the software) of the medical device 21. The remote monitoring service 24 initiates the page by sending a page request to the two-way paging network 23 with the desired page address and data. In general, any wired or wireless data transmission network may be used to initiate the page. In one embodiment, the monitoring service 24 initiates this page by calling a "pager" number previously assigned to the medical device 21, using a standard telephone line and modem connection. In other embodiments, other types of communication links can be used between the remote monitoring service 24 and the two-way paging network 23. The remote monitoring service 24 encodes instructions to be transferred by the paging system. Further, error correction techniques are often used to ensure correct reception of the encoded instructions in the presence of noise in the transmission channel. The two-way paging network 23 includes a paging switch (not

shown) that generates a page with the desired instruction, addressed to the desired medical device 21.

In a next block 33, the medical device 21 receives the page via the paging module 22 and then extracts the instructions from the page. The paging module 22 may be configured to send an acknowledgement page back to the two-way paging network 23 to confirm receipt of the page. Then in a block 35, the medical device 21 performs the extracted instructions. In a next block 37, the medical device 21, in this example, transmits a message back to the remote monitoring service 24 through the two-way paging network 23. In accordance with one two-way paging protocol, this "return page" is transmitted in a return channel that is different from the channel (i.e., frequency band) used to transmit the page initiated by the remote paging service 24 in block 31. This type of system can allow the medical device 21 to initiate transmission of the return page without having to wait to be polled by the two-way paging network 23. The return channel page or message contains self-test results, status data, or condition data, depending on the nature of the instructions sent by the remote monitoring service 24. A transmission from the medical device 21 can be immediately provided by the two-way paging network 23 to the remote monitoring service 24 via the same data transmission network that the remote monitoring service 24 used to initiate the page. For example, two-way paging network 23 may use a telephone/modem connection to transmit the data to the remote monitoring service. Alternatively, the two-way paging network 23 and the remote monitoring service 24 may be configured to store the return message in a "mail box" that the monitoring service 24 can later retrieve and analyze.

In a next block 39, the remote monitoring service 24 then extracts the information from the return page. This information can then be displayed for analysis by a technician at the remote monitoring service 24. Alternatively, the remote monitoring service 24 may be configured with a computer programmed to analyze the information. The remote monitoring service 24 can then alert a technician or even the customer when analysis of the information indicates a problem. It will be appreciated that in light of the present disclosure, those skilled in the art can implement without undue experimentation, a remote communication system for medical devices in which several medical devices are monitored by the remote monitoring service 24 using the two-way paging network 23. The remote monitoring service 24 would be configured to "poll" each medical device at least

once per day up to several times a day, depending on the number of medical devices and the capacity of the two-way paging network 23.

FIGURE 4 is a block diagram illustrative of medical device 21 (FIGURE 2) being implemented with a defibrillator, according to one embodiment of the present invention. Although a defibrillator is used in this embodiment, in light of this disclosure, those skilled in the art will be able to implement other embodiments using other types of medical equipment, without undue experimentation. In addition to the two-way paging module 22, the defibrillator 21 includes a controller 40, a power source 41, an energy storage device 42, an output circuit 43 and output electrodes 44 and 45. To facilitate understanding of the invention, the same reference number may be used in several drawings to indicate elements having the same or similar structure or function. In this embodiment, the two-way paging module 22 is implemented with a CreataLink2™ two-way paging module, available from Motorola, Inc. Schaumburg, Illinois. This embodiment uses the ReFLEX™ two-way paging protocol. Of course, in other embodiments, other suitable OEM (original equipment manufacturer) two-way paging modules and/or two-way paging protocols may be used.

In addition, the controller 40 includes a microprocessor (not shown) such as, for example, a model 68332 available from Motorola, along with a memory 46. Preferably, the memory 46 includes random access memory such as a DRAM (dynamic random access memory) or SRAM (static random access memory), and non-volatile memory such as an EEPROM (electrically erasable programmable read only memory). The EEPROM can be used to store software programs executed by the processor (not shown). In addition, the EEPROM allows the stored software programs to be remotely updated. The power source 41 is implemented with a battery, such as a LP500 battery available from Medtronic Physio-Control Manufacturing Corp., Redmond, Washington. The energy storage device 42 is implemented with a capacitor with a capacitance of about 190-200 μF. The output circuit 43 is implemented in an H-bridge configuration, which facilitates generating biphasic output pulses. For example, the output circuit 43 can be implemented as disclosed in U.S. Patent Application Serial No. 08/811,833 filed March 5, 1997, entitled "H-Bridge Circuit For Generating A High-Energy Biphasic Waveform In An External Defibrillator" by J.L. Sullivan et al. In one embodiment, the controller 40, the power source 41, the energy storage device 42, the output circuit 43 and the electrodes 44 and 45 are the same as used in a LP500 AED available from Medtronic

Physio-Control Manufacturing Corp. That is, the hardware aspect of medical device 21 is basically equivalent to a LP500 AED with the addition of the two-way pager module 22, along with suitable software programming stored in the memory 46.

FIGURE 5 is a block diagram illustrative of the remote monitoring service 24 (FIGURE 2), according to one embodiment of the present invention. In this embodiment, the remote monitoring service 24 includes a modem 51, a control unit 52 and a user interface 53 having a display. The modem 51 is part of interface 27 (FIGURE 2) and is implemented with a standard commercially available modem. The control unit 52 is connected to the modem 51 and includes a standard processor and associated memory (not shown). The control unit 52 is programmed to initiate pages to be transmitted through the two-way paging network 23 (FIGURE 2), as described above in conjunction with FIGS. 2 and 3. For example, the control unit 52 may be programmed to initiate "self-test" pages to be sent to the medical device 21 (FIGURE 2) according to a programmed schedule. In particular, the control unit 52 would send a page request to the two-way paging network 23 (FIGURE 2) through the modem 51 as previously described, which would then broadcast the requested page to the medical device 21. In addition, the control unit 52 is programmed to process return pages transmitted by the medical device 21 (FIGURE 2).

In this embodiment, the control unit 52 is also connected to the user interface 53. This feature can be used to display the processed return channel page so that a user (not shown) can view the information contained in the received return page. The user can then analyze the displayed information and take appropriate action. For example, the return channel page may contain the results of a self-test initiated by the remote monitoring service 24. If the results of the self-test indicate that the medical device 21 failed the self-test, the user can then contact the customer (or the party responsible for the medical device 21) to take the medical device 21 to a repair facility. The user may also use the user interface 53 to initiate pages to the medical device 21. For example, this feature may be used to send a software update or reconfiguration information to the medical device 21.

FIGURE 6 is a flow diagram illustrative of the operation of the remote wireless communication system 20 (FIGURE 2), according to another embodiment of the present invention. This embodiment utilizes the ability of some two-way pager protocols to support independent transmission of a return channel page to send

a message to the remote monitoring service 24. That is, the medical device 21 can send a page to the remote monitoring service 24 without first having received a page from the remote monitoring service 24. In a block 61, the medical device 21, in a self-monitoring process, determines the status of the medical device 21. For example, the medical device 21 may be an AED having a control unit (e.g., the controller 40 in FIGURE 4) that constantly monitors the voltage of its battery (e.g., the power source 41 in FIGURE 4) to detect if the battery voltage drops below a predetermined threshold level. This self-monitoring process may monitor other parameters or initiate self-tests on a regular basis. For example, some medical devices include an on-board controller and clock system. The medical device's controller can be programmed to periodically initiate self-tests. Alternatively, the medical device 21 may initiate such self-monitoring and/or self-tests upon being activated or after being used. For example, the medical device 21 may be programmed to initiate notification pages indicating when the medical device 21 is used or if the medical device 21 fails in an attempted use.

In a next block 63, the medical device 21 initiates a page through two-way paging network 23 to provide the status or self-test results to the remote monitoring service 24. Block 63 is performed in essentially the same manner as block 37 (FIGURE 3), except that in block 63, the return channel page is not in response to a page sent by the remote monitoring service 24. That is, the status or self-test results are generated by the medical device 21 and sent via return channel page to the remote monitoring service 24 without prompting by the remote monitoring service 24. This embodiment can be used to reduce the processing load on the control unit 52 (FIGURE 5) of the remote monitoring service 24 when a large number of medical devices are being monitored. Blocks 65 and 67 are then performed by the remote monitoring service 24 in essentially the same manner as blocks 37 and 39 (FIGURE 3), described above.

FIGURE 7 is a block diagram illustrative of a medical device 70 configured to provide information regarding the location of the medical device 70 to the remote monitoring service 24 (FIGURE 2), according to one embodiment of the present invention. In this embodiment, the medical device 70 includes the two-way paging module 22 (as described above in conjunction with FIGURE 2), a GPS (global positioning system) module 71 and a controller 73. In addition, the medical device 70 includes the normal medical device circuitry 75 that the medical device 70 would have to perform its intended medical functions. For example, if the medical

device 70 were an AED, the medical device circuitry 75 would typically include the power source 41, the energy storage device 42, the output circuit 43 and the electrodes 44 and 45 that an AED described above in conjunction with FIGURE 4.

In one embodiment, the controller 73 is the same as the controller 40 (FIGURE 4) with additional software programming to interact with the GPS module 71. The GPS module 71 is implemented with a standard OEM GPS module such as, for example, a suitable module of the SiRFstar I/LX Product Family, available from SiRF Technology, Inc., Santa Clara, California. The GPS module 71 is used to detect the location of the medical device 70 in the standard manner. In particular, the controller 73 is programmed to query the GPS module 71 to provide the current location of the medical device 70, which the controller 73 then causes to be transmitted to the remote monitoring service 24 (FIGURE 2) using the two-way paging module 22. The medical device 70 can provide its current location in response to a request from the remote monitoring service 24 as described above in conjunction with FIGURE 3, or on its own as described above in conjunction with FIGURE 6. This feature can be used to track the location of portable medical devices such as AEDs.

FIGURE 8 is a block diagram illustrative of a remote wireless and data network communication system 80 for use with medical devices, according to one embodiment of the present invention. System 80 is similar to system 20 (FIGURE 2) except that the two-way paging service 23 (FIGURE 2) includes a data network point-of-presence (POP) interface and the channel 26 (FIGURE 2) includes a data network interface 81. For example, the data network and data network POP may be implemented using the Internet and a website. In this embodiment, the remote monitoring service 24 is configured to send page requests for pages to remote medical devices (not shown) through the data network POP of the two-way paging service 23, using the data network interface 81. The data network interface 81 is configured to follow the procedures defined by the two-way paging service 23 for sending pages using its data network POP. In response to data network POP-based page requests from the remote monitoring service 24, the two-way paging service 23 sends out pages to the addressed remote medical devices in the standard manner. The remote medical devices then send return pages as described above. The return pages (and self-initiated pages) from the remote medical devices are processed by the two-way paging service 23, which then provides the pages from the remote medical devices to the remote monitoring service 24. As previously described, the two-way

paging service 23 may provide the return page via a standard telephone connection as previously described. Alternatively, the return page may be in the form of data network email.

In an alternative embodiment, the two-way paging service 23 may also support direct data network email page requests. This alternative embodiment is similar to the embodiment of FIGURE 8, except that the remote monitoring service 24 is configured to send page requests to the two-way paging service 23 by internet email rather than through accessing the data network POP of the two-way paging service 23.

FIGURE 9A illustrates the data network POP interface of the remote monitoring service 24 (FIGURE 8), according to one embodiment of the present invention. In this embodiment, the remote monitoring service 24 accesses the data network through a data network access provider 90. The remote monitoring service 24 includes an interface 91 for establishing a connection with the data network access provider 90 over a line 92. The interface 91 can be a standard modem and the line 92 can be a standard telephone network. Alternatively, the remote monitoring service can be connected to the data network access provider 90 using other types of communication technologies such as cable, integrated services digital network (ISDN), asynchronous digital subscriber line (ADSL), etc.

FIGURE 9B illustrates the Internet interface of the remote monitoring service 24 (FIGURE 8), according another embodiment of the present invention. This embodiment is similar to the embodiment of FIGURE 9A, except that the remote monitoring service uses a direct data network connection instead of a data network access provider 90. In this embodiment, the remote monitoring service 24 is connected to the data network by a server 93. The remote monitoring service 24 is connected to the server 93 via a line 95. The line 95 can be any suitable connection such as, for example, a direct cable connection, or an internal or Intranet network connection such as an Ethernet connection. Such direct data network connections are well known using commercially available equipment and software.

FIGURE 10 illustrates part of a remote wireless communication system 100 for use with medical devices, according to another embodiment of the present invention. The system 100 includes a conventional medical device 101 and a separate communication device 103. The rest of the system is as described in conjunction with FIGURE 2, with the medical device 101 and the communication device 103 replacing the medical device 21. The communication device 103 and the

medical device 101 include an interface 105 and an interface 107, respectively, for supporting communication between the devices. In one embodiment, the interfaces 105 and 107 form a RS-232-C bus connection.

The communication device 103 includes a paging module 22 as described above in conjunction with FIGURE 2. The communication device 103 has a controller 109 similar to controller 73 (FIGURE 7) and is configured to receive pages sent by the remote monitoring service 24 and pass instructions within the received pages to the medical device 101. In addition, the communication device 103 is configured to download data (e.g., self-test data) from the medical device 101 (either in response to the page from the remote monitoring service 24 or self-initiated) and send a page with the downloaded data to the remote monitoring service 24. The communication device 103 may also include a GPS module 71 (FIGURE 7) for tracking the location of medical device 101. This embodiment is advantageously used to upgrade existing medical devices that have a communication port.

FIGURE 11 illustrates part of a remote wireless communication system 110 for use with medical devices, according to another embodiment of the present invention. The system 110 includes a medical device 111 having a smart subsystem 113. The rest of the system 110 is as described above in conjunction with FIGURE 2, with the medical device 111 replacing medical device 21.

The smart subsystem 113 can be a smart battery similar to that disclosed in U.S. Patent Application entitled "Smart Battery With Maintenance And Testing Functions, Communications, And Display", Serial No. 09/237,193 filed on January 26, 1999, which is assigned to the same assignee as the present invention, except that the smart subsystem 113 includes paging module 22. The smart subsystem 113 includes a controller 115 that is similar to the controller 73 described above in conjunction with FIGURE 7, which allows the smart subsystem 113 to be configured to inter-operate with the paging module 22 as previously described.

The embodiments of the remote wireless communication system described above are illustrative of the principles of the present invention and are not intended to limit the invention to the particular embodiments described. For example, in light of the present disclosure, those skilled in the art can adapt the two-way paging communication system to medical devices other than AEDs without undue experimentation. In addition, those skilled in the art can adapt the two-way paging communication system to use other wired or wireless public data network interfaces or wireless telephone interfaces in other embodiments. Accordingly, while the

preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

I claim:

1. A communication system comprising:

a medical device having a two-way paging module;

a two-way paging network; and

a remote monitoring service,

wherein the remote monitoring service is configured to send a page to the medical device using the two-way paging network, the page including a request for information from the medical device, and wherein, in response to receiving the page, the medical device is configured to obtain the requested information and send a return message back to the remote monitoring service using the two-way paging network, the return message including the requested information.

2. The system of Claim 1 wherein the medical device is a portable defibrillator.

3. The system of Claim 1 wherein the page includes an instruction for the medical device to perform a self-test, and wherein the medical device is configured to perform the requested self-test in response to the instruction.

4. The system of Claim 1 wherein the page includes an instruction for the medical device to send status information back to the remote monitoring service and wherein the medical device is configured to obtain the status in response to the instruction.

5. The system of Claim 1 wherein the page includes configuration information to update the configuration of the medical device, and wherein the medical device is configured to update its configuration in response to receiving the configuration information.

6. The system of Claim 1 wherein the page includes software update information to update software stored in the medical device, and wherein the medical device is configured to update the software stored in the medical device in response to receiving the software update information.

7. The system of Claim 1 wherein the medical device is further configured to autonomously obtain medical device information and send a message

to the remote monitoring service using the two-way paging network, the message including the medical device information, the medical device information including status, self-test, or configuration information.

8. The system of Claim 1 wherein the medical device comprises:

a controller with a memory;

a two-way paging module coupled to the controller,

wherein the controller and two-way paging module are configured to receive and process pages sent to the medical device by the remote monitoring service over the two-way paging network and further configured to send return messages to the remote monitoring service over the two-way paging network..

9. The system of Claim 1 wherein the remote monitoring service comprises:

a control unit, wherein in the control unit is configured to selectively initiate a page to the medical device using the two-way paging network;

an interface coupled to the control unit, wherein the interface is configured to support communication between the control unit and the two-way paging network; and

a user interface having a display coupled to the control unit, the user interface being configured to support transfer of information between a user and the control unit.

10. The system of Claim 1 further comprising a global positioning system (GPS) module coupled to the controller, wherein the controller and GPS module are configured to provide the information indicative of the location of the medical device to the remote monitoring service using the two-way paging network.

11. The system of Claim 1 wherein the medical device comprises a smart subsystem, the smart subsystem including the two-way paging module, and wherein the requested information is related to the status of the smart subsystem.

12. The system of Claim 11 wherein the smart subsystem comprises a battery for providing power to the medical device.

13. The system of Claim 1 wherein the remote monitoring service is configured to send a page to the medical device by communicating with the two-way

paging network through a data network.

14. The system of Claim 13 wherein the data network is an Internet.

15. The system of Claim 14 wherein the remote monitoring service is configured to use an Internet service provider to communicate over the Internet.

16. A method for a remote monitoring service to communicate with a medical device using a two-way paging network, the method comprising:

initiating a page from the remote monitoring service to the medical device using the two-way paging network, the page including a request by the remote monitoring service for information from the medical device;

receiving the page in the medical device;

obtaining the requested information in response to receiving the page in the medical device; and

sending a return message from the medical device to the remote monitoring service using the two-way paging network, the message including the requested information.

17. The method of Claim 16 wherein the page includes an instruction for the medical device to perform a self-test, and wherein the medical device is configured to perform the requested self-test in response to the instruction.

18. The method of Claim 16 wherein the page includes an instruction for the medical device to send status information back to the remote monitoring service and wherein the medical device is configured to obtain the status in response to the instruction.

19. The method of Claim 16 wherein the page includes configuration information to update the configuration of the medical device, and wherein the medical device is configured to update its configuration in response to receiving the configuration information.

20. The method of Claim 16 wherein the page includes software update information to update software stored in the medical device, and wherein the medical device is configured to update the software stored in the medical device in response to receiving the software update information.

21. The method of Claim 16 wherein the medical device is further configured to autonomously obtain medical device information and send a message to the remote monitoring service using the two-way paging network, the message including the medical device information, the medical device information including status, self-test, or configuration information.

22. The method of Claim 16 wherein the medical device is a portable defibrillator.

23. The method of Claim 16 further comprising determining a location of the medical device using a global positioning system (GPS) module and providing information indicative of the location of the medical device to the remote monitoring service using the two-way paging network.

24. The method of Claim 16 wherein the medical device comprises a smart subsystem, the smart subsystem including the two-way paging module, and wherein the requested information is related to the status of the smart subsystem.

25. The method of Claim 24 wherein the smart subsystem comprises a battery for providing power to the medical device.

26. The method of Claim 16 wherein the remote monitoring service is configured to send a page to the medical device by communicating with the two-way paging network through a data network.

27. The method of Claim 26 wherein the data network is an Internet.

28. The method of Claim 27 wherein the remote monitoring service is configured to use an Internet service provider to communicate over the Internet.

29. A defibrillator comprising:

a power source;

a charging circuit coupled to the power source;

an energy storage device coupled to the charging circuit;

an output circuit coupled to the energy storage device;

a pair of electrodes coupled to the output circuit;

a two-way paging module; and

a controller having a memory coupled to the two-way paging module, charging circuit and the output circuit, wherein the controller is configured to selectively cause the charging circuit to transfer energy from the power source to the energy storage device and to cause the output circuit to transfer energy from the energy storage device to the electrodes, and

wherein the controller is further configured to operate the two-way paging module to (i) receive a page from a remote monitoring service via a two-way paging network, the page including a request for information from the medical device, and (ii) send a message to the remote monitoring service via the two-way paging network, the message including the requested information.

30. The defibrillator of Claim 29 wherein the page includes an instruction for the defibrillator to perform a self-test, and wherein the defibrillator is configured to perform the requested self-test in response to the instruction.

31. The defibrillator of Claim 29 wherein the page includes software update information to update software stored in the defibrillator, and wherein the defibrillator is configured to update the software stored in the defibrillator in response to receiving the software update information.

32. The defibrillator of Claim 29 wherein the page includes an instruction for the defibrillator to send status information back to the remote monitoring service and wherein the defibrillator is configured to obtain the status in response to the instruction.

33. The defibrillator of Claim 29 wherein the page includes configuration information to update the configuration of the defibrillator, and wherein the defibrillator is configured to update its configuration in response to receiving the configuration information.

34. The defibrillator of Claim 29 wherein the defibrillator is further configured to autonomously obtain defibrillator information and send a message to the remote monitoring service using the two-way paging network, the message including the defibrillator information, the defibrillator information including status, self-test, or configuration information.

35. The defibrillator of Claim 29 further comprising a global positioning system (GPS) module coupled to the controller, wherein the controller and GPS module are configured to provide the information indicative of the location of the defibrillator to the remote monitoring service using the two-way paging network.

36. A defibrillator comprising:

a power source;

a charging circuit coupled to the power source;

an energy storage device coupled to the charging circuit;

an output circuit coupled to the energy storage device;

a pair of electrodes coupled to the output circuit;

a two-way paging module;

defibrillator control means for selectively causing the charging circuit to transfer energy from the power source to the energy storage device and to cause the output circuit to transfer energy from the energy storage device to the electrodes; and

pager module control means, coupled to the two-way paging module, for receiving and processing a page from a remote monitoring service via a two-way paging network, the page including a request for information from the medical device, and for sending a message to the remote monitoring service via the two-way paging network, the message including the requested information.

37. The defibrillator of Claim 36 wherein the page includes an instruction for the defibrillator to perform a self-test, and wherein the defibrillator is configured to perform the requested self-test in response to the instruction.

38. The defibrillator of Claim 36 wherein the page includes software update information to update software stored in the defibrillator, and wherein the defibrillator is configured to update the software stored in the defibrillator in response to receiving the software update information.

39. The defibrillator of Claim 36 wherein the page includes an instruction for the defibrillator to send status information back to the remote monitoring service and wherein the defibrillator is configured to obtain the status in response to the instruction.

40. The defibrillator of Claim 36 wherein the page includes configuration information to update the configuration of the defibrillator, and wherein the

defibrillator is configured to update its configuration in response to receiving the configuration information.

41. The defibrillator of Claim 36 wherein the defibrillator is further configured to autonomously obtain defibrillator information and send a message to the remote monitoring service using the two-way paging network, the message including the defibrillator information, the defibrillator information including status, self-test, or configuration information.

42. The defibrillator of Claim 36 further comprising a global positioning system (GPS) module coupled to the controller, wherein the controller and GPS module are configured to provide the information indicative of the location of the defibrillator to the remote monitoring service using the two-way paging network.

43. The defibrillator of Claim 36 wherein a processor and a memory are used to implement the defibrillator control means and pager module control means.

44. A communication circuit for use in conjunction with a medical device, a two-way paging network and a remote monitoring service, the communication device comprising:

a controller; and

a two-way paging circuit coupled to the controller,

wherein in response to a page from the remote monitoring service using the two-way paging network, the page including a request for information from the medical device, the communication device is configured to obtain the requested information from the medical device and send a return message back to the remote monitoring service using the two-way paging network, the return message including the requested information.

45. The communication circuit of Claim 44, wherein the communication circuit is in a separate unit external to the medical device, the separate unit being configured to be selectively coupled to the medical device.

46. The communication circuit of Claim 45 further comprising a GPS module coupled to the controller.

Fig. 1 (PRIOR ART)

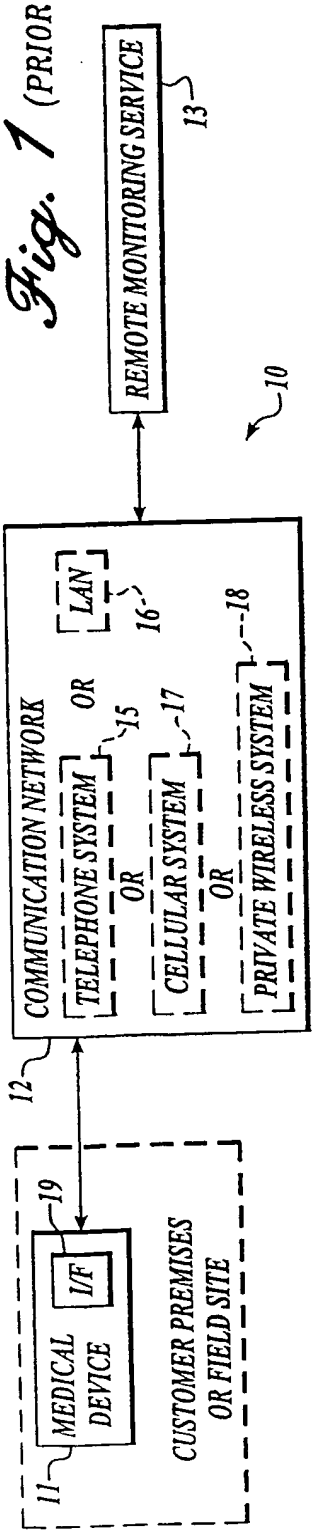

Fig. 2

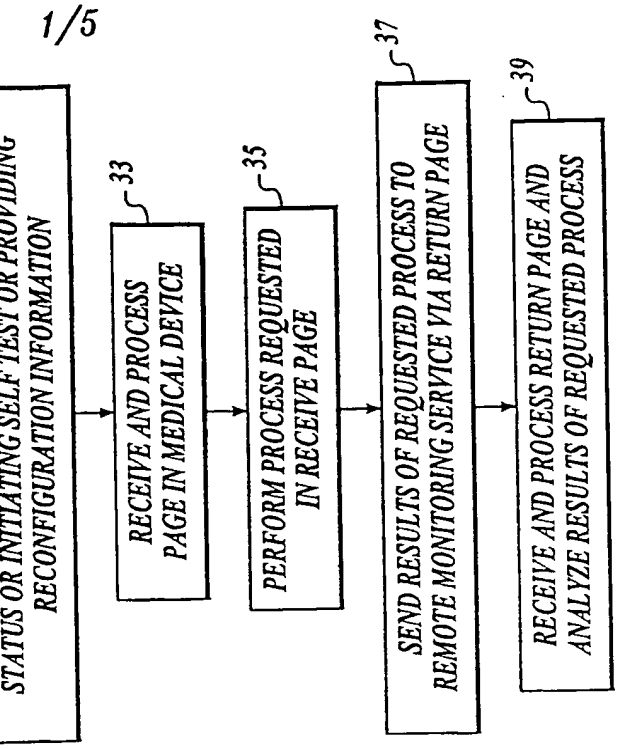

Fig. 3

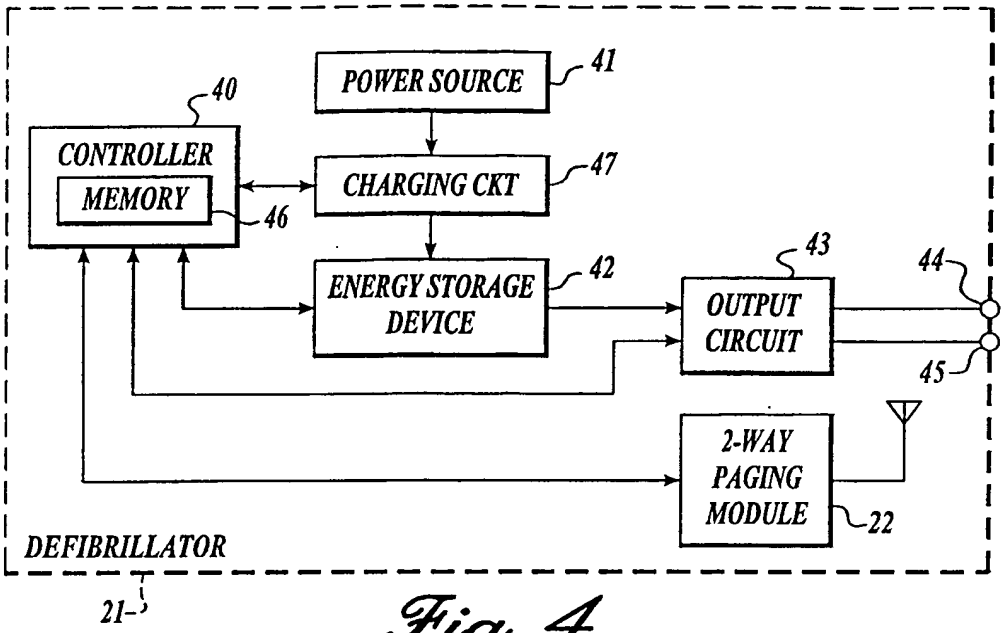
POWER SOURCE
41
40
CONTROLLER
MEMORY
46
CHARGING CKT
47
ENERGY STORAGE DEVICE
42
43
OUTPUT CIRCUIT
44
45
2-WAY PAGING MODULE
22
DEFIBRILLATOR
21

Fig. 4

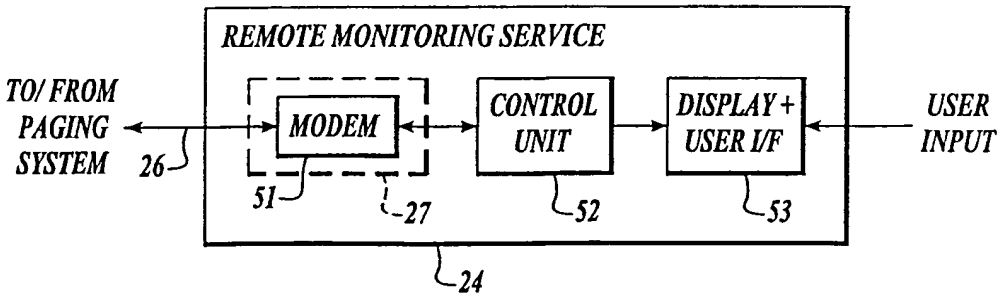
REMOTE MONITORING SERVICE
TO/ FROM PAGING SYSTEM
26
MODEM
51
27
CONTROL UNIT
52
DISPLAY + USER I/F
53
USER INPUT
24

Fig. 5

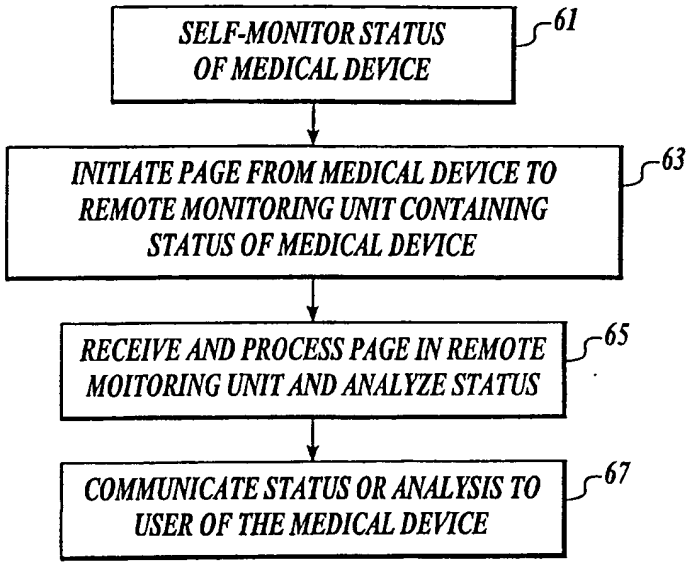
SELF-MONITOR STATUS OF MEDICAL DEVICE
61
INITIATE PAGE FROM MEDICAL DEVICE TO REMOTE MONITORING UNIT CONTAINING STATUS OF MEDICAL DEVICE
63
RECEIVE AND PROCESS PAGE IN REMOTE MOITORING UNIT AND ANALYZE STATUS
65
COMMUNICATE STATUS OR ANALYSIS TO USER OF THE MEDICAL DEVICE
67

Fig. 6

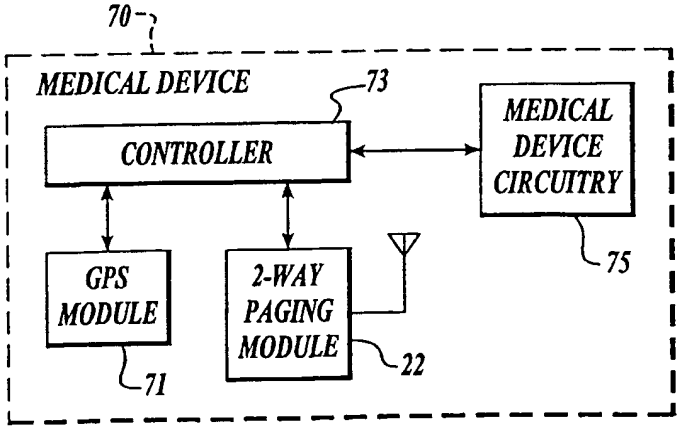
70
MEDICAL DEVICE
73
CONTROLLER
MEDICAL DEVICE CIRCUITRY
75
GPS MODULE
71
2-WAY PAGING MODULE
22

Fig. 7

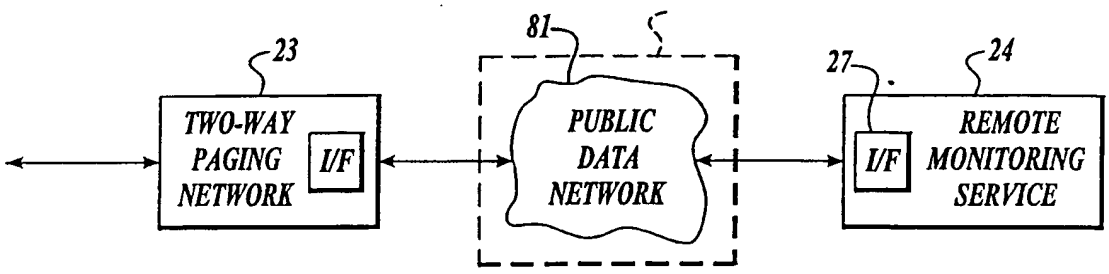

Fig. 8

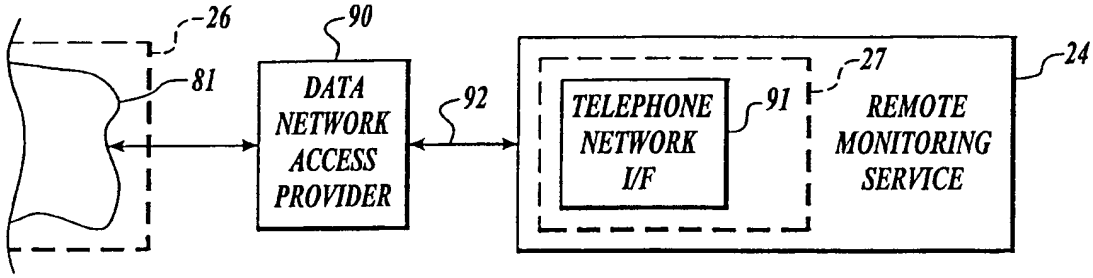

Fig. 9A

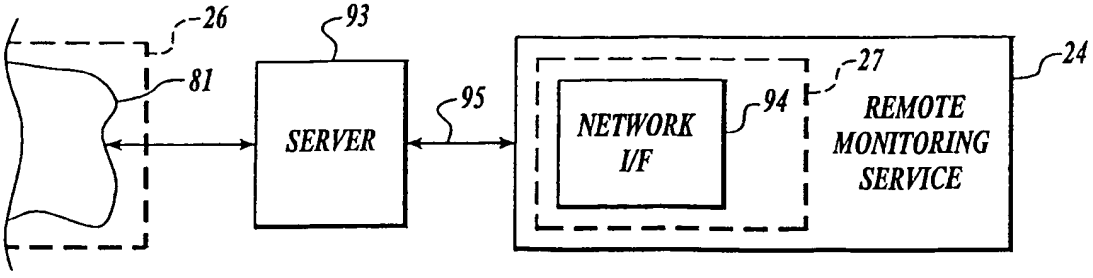

Fig. 9B

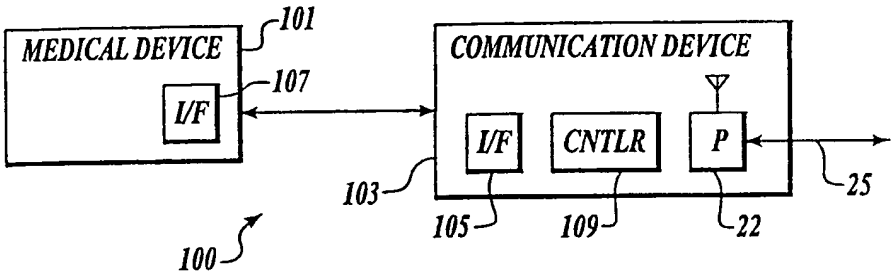
MEDICAL DEVICE
101
107
I/F
COMMUNICATION DEVICE
I/F
CNTLR
P
25
103
105
109
22
100

Fig. 10

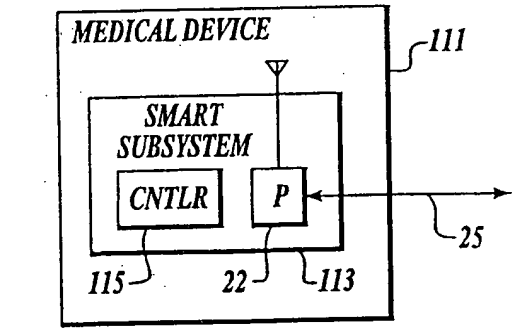
MEDICAL DEVICE
111
SMART SUBSYSTEM
CNTLR
P
25
115
22
113
110

Fig. 11

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 00/13020

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/08 H04M11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04M A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 321 618 A (GESSMAN LAWRENCE) 14 June 1994 (1994-06-14) column 3, line 3 - line 57 column 4, line 19 - line 56 column 7, line 18 - line 56; figure 1 --- -/--	1-6,8,9, 16-20, 22, 29-33, 36-40, 43-45

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 October 2000	11/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tsapelis, A

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 00/13020

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 337 044 A (ARNOLD DAVID ET AL) 9 August 1994 (1994-08-09) column 3, line 41 -column 4, line 57 column 5, line 1 -column 6, line 50 column 7, line 52 -column 8, line 4 column 10, line 5 -column 11, line 58; figure 1	1-6,8,9, 16-20, 22, 29-33, 36-40, 43-45
A	US 5 752 976 A (DUFFIN EDWIN G ET AL) 19 May 1998 (1998-05-19) column 4, line 34 -column 5, line 53 column 6, line 19 -column 7, line 30; figures 1,2,4,5	10,23, 35,42,46

4

INTERNATIONAL SEARCH REPORT

..nformation on patent family members

Inter onal Application No
PCT/US 00/13020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5321618 A	14-06-1994	NONE	
US 5337044 A	09-08-1994	NONE	
US 5752976 A	19-05-1998	AU 709767 B	09-09-1999
		AU 6176996 A	22-01-1997
		CA 2224520 A	09-01-1997
		EP 0939662 A	08-09-1999
		JP 11508165 T	21-07-1999
		WO 9700708 A	09-01-1997
		US 6083248 A	04-07-2000